SPECIFICATION:

a) Page 8, Paragraph between Lines 21-27, change as:

B1

After act 142, the control is returned to act 141 so that acts 141 and 142 are executed in a loop for each multicast connection request. According to one embodiment as shown further below it is not necessary to have more than $3*n-1$ middle stage switches in network ~~o100 f~~ <u>100 of</u> the FIG. 1A, where the number of inlet links IL1-IL3 equals the number of outlet links OL1-OL3, both represented by the variable n for the network to be a strictly nonblocking symmetrical switching network, when the scheduling method of FIG. 1B is used.

b) Paragraph between Page 9, Line 29 and Page 10, Line 17, change as:

B2

In general, an $(N_1 * N_2)$ asymmetric network of three stages can be operated in strictly nonblocking manner if $m \geq 2*n_1+n_2-1$ (and in the example of FIG. 2B $m=2*n_1+n_2-1$")", wherein network (FIG. 2B) has r_1 $(n_1 * m)$ switches IS1-ISr_1 in the first stage, m $(r_1 * r_2)$ switches MS1-MSm in the middle stage, and r_2 $(m * n_2)$ switches OS1-OSr_2 in the last stage where $N_1 = n_1 * r_1$ is the total number of inlet links and $N_2 = n_2 * r_2$ is the total number of outlet links of the network. Each of the m switches MS1-MS($2*n_1+n_2-1$) are connected to each of the input switches through r_1 first internal links (for example the links FL11-FL$r_1$1 connected to the middle switch MS1 from each of the input switch IS1-ISr_1), and connected to each of the output switches through r_2 second internal links (for example the links SL11-SL$r_2$1 connected from the middle switch MS1 to each of the output switch OS1-OSr_2). Such a multi-stage switching network is denoted as a $V(m,n_1,r_1,n_2,r_2)$ network. For the special symmetrical case where $n_1 = n_2 = n$ and $r_1 = r_2 = r$, the three-stage network is denoted as a $V(m,n,r)$ network. In general, the set of inlet links is denoted as $\{1,2,\ldots,r_1 n_1\}$ and the set of output switches are denoted as $O = \{1,2,\ldots,r_2\}$. In an asymmetrical three-stage network, as shown in FIG. 2B with n_1 inlet links for each of r_1 input switches, n_2 outlet links for each of r_2 output switches, no more than $2*n_1+n_2-1$ middle stage switches

B2

are necessary for the network to be strictly nonblocking, again when using the scheduling method of FIG. 1B. The network has all connections set up such that each connection passes through at most two middle switches to be connected to all destination outlet links.

c) Page 11, Paragraph between Lines 22-25, change as:

B3

Two multicast connection requests $I_i = O_i$ and $I_j = O_j$ for $i \neq j$ are said to be compatible if and only if $O_i \bigcap O_j = \phi$. It means when the requests I_i and I_j are compatible, ~~when the inlet links i, j~~ <u>and if the inlet links i and j</u> do not belong to the same input switch, they can be set up through the same middle switch.

d) Page 14, Paragraph between Lines 9-22, change as:

B4

Act 142 of FIG. 3A is implemented in one embodiment by acts 242A-242D illustrated in FIG. 4A. Specifically, in this embodiment, act 142A is implemented by acts 242A, 242C, and 242D wherein a loop is formed to check if a middle switch has an available link to the input switch, and also has available links to all the required destination switches. In this implementation, the same loop is also used with an additional act 242B to implement act 142B of FIG. 3A. Use of the same loop as illustrated in FIG. 4A provides efficiency by eliminating repetition of the same acts, namely acts 242A, 242C, and 242D that would otherwise have been repeated if act 142B is performed independent of act 142A (FIG. 3A). In act 242B, the method of FIG. 4A checks if another middle switch has available links to destinations that could not be reached by use of the middle switch in act 242A (described above). As illustrated in FIG. 4B, act 242B is reached when the decision in act 242A is ~~“NO”~~ <u>“no”</u>. In one specific example, acts 242A-242B of ~~FIG. 4C~~ <u>FIG. 4B</u> are implemented by use of the information developed in act 242A, for an efficient implementation as discussed next.

e) Page 19, Paragraph between Lines 11-21, change as:

B5

An alternative implementation saves (see act 305 of FIG. 4C) an array 540 (see FIG. 4D) of unavailable destinations from middle switch MSi, at the time middle

switch MSi is first paired with a middle switch, (e.g. MSj) other than itself when attempting to satisfy the connection request 510. Such saving of array 540 eliminates the need for each destination of the connection request 510 to be checked for middle switch MSi, when middle switch MSi is paired with another middle switch (e.g. MSk). If the array 540 of unavailable destinations from MSi is saved once, only these destinations (in array 540) need to be checked for availability in middle switch MSk, which improves the speed of the computation. The embodiment of FIG. 4D can be implemented to set up connections in a controller <u>580</u> and memory <u>500</u> (described above in reference to FIG. 1A, FIG. 2A, and FIG. 2B etc.).

B5

f) Paragraph between Page 26, Line 17 and Page 27, Line 5, change as:

In accordance with the invention, in any of the recursive three-stage networks each connection can fan out in the first stage switch into at most two middle stage subnetworks, and in the middle switches and last stage switches it can fan out any arbitrary number of times as required by the connection request. For example as shown in the network of FIG. 5A, connection I_1 fans out in the first stage switch IS1 once into middle stage subnetwork MS1. In middle stage subnetwork MS1 it fans out four times into output switches OS1, OS2, OS3 and OS5. In output switches OS1 and OS3 it fans out twice. Specifically from output switch OS1 into outlet links OL1, OL2, and from output switch OS3 into outlet links OL5, OL6. In output switches OS2 and OS5 it fans out once into outlet links OS4 and OS9 respectively. However in the three-stage network MS1, it can fan out at most twice in the first stage, for example connection I_1 fans out twice in the input switch ~~MIS 1~~ <u>MIS1</u> into middle switches MMS2 and MMS3 of the three-stage subnetwork MS1. Similarly a connection can fan out arbitrary number of times in the middle and last stages of any three-stage subnetwork. For example connection I_1 fans out twice in middle switch MMS2 into output switches MOS1 and MOS2 of three-stage subnetwork MS1. In the output switch MOS1 of three-stage subnetwork MS1 it fans out twice into output switches OS1 and OS2. And in the output switch MOS2 of three-stage subnetwork MS1 it fans out once into output switch OS3. Also the connection I_1 fans out in

B6

B6

middle switch MMS3 once into output switch MOS2 of the three-stage subnetwork MS1 and from there once into output switch OS5.

g) Page 28, Paragraph between Lines 9-19, change as:

B7

In general when $m = (x+1) * n - 1$ and $x \geq 2$ each multicast connection can be fanned out into at most x middle switches and the $V(m,n,r)$ <u>network</u> is operated in strictly nonblocking manner. Similarly, when $m = x * n_1 + n_2 - 1$, the $V(m,n_1,r_1,n_2,r_2)$ network is operated in strictly nonblocking manner if each multicast connection is fanned out into at most x middle switches. FIG. 7A shows a general symmetrical multi-stage network with $m = (x+1) * n - 1$ middle switches. Excepting for the middle switches to be $m = (x+1) * n - 1$, the description of FIG. 7A is similar to FIG. 2A. FIG. 7B shows the scheduling method by fanning out into at most x middle switches. Excepting for the additional act 142X of testing for x middle switches and setting up a connection through x middle switches in act 142C, the description of the method of FIG. 7B is similar to the method of FIG. 3A.

h) Page 29, Paragraph between Lines 1-9, change as:

B8

For example, in one embodiment a method of the type described above is modified as follows when the number of output switches r_2 is less than or equal to four. Specifically, a three-stage network is operated in strictly nonblocking manner when the multicast connection is fanned out only once in the input stage, with m number of middle stage switches where

$m \geq \lfloor \sqrt{r_2} \rfloor * MIN(n_1, n_2)$ when $\lfloor \sqrt{r_2} \rfloor$ is > 1 and odd, or when $\lfloor \sqrt{r_2} \rfloor = 2$,

$m \geq (\lfloor \sqrt{r_2} \rfloor - 1) * MIN(n_1, n_2)$ when $\lfloor \sqrt{r_2} \rfloor$ is > 2 and even, and

$m \geq n_1 + n_2 - 1$ when $\lfloor \sqrt{r_2} \rfloor = 1$. So when r_2 is less than ~~equal to fiver~~ <u>or equal to five</u> a three-stage network is operated in strictly nonblocking manner for $m \leq 2 * n$.

First applicant addresses the novelty and unobviousness of the current invention over the prior art. Also applicant submits that the U.S. Patent 5,801,641 by Yang et. al (over which the issues of novelty and unobviousness of the current invention is raised) is already referenced in the prior art section of the current application on page 3 lines 7-13. U.S. Patent 5,801,641 by Yang et. al. is based on the article by the same authors and entitled, "Non-blocking Broadcast Switching Networks" IEEE Transactions on Computers, Vol. 40, No. 9, September 1991. Applicant also submits that he has reviewed all the other cited references and they do not show the current invention or render it obvious.

I. RESPONSE TO ADDRESS THE REJECTIONS 1 AND 2:

The general problem definition (common to the prior art and the current invention):

The current invention and the prior art cited including U.S. Patent 5,801,641 by Yang et. al are about the following network:

1) The nonblocking design and operation of three-stage network for multicast connections comprising an input stage having r_1 switches and n_1 inlet links for each of r_1 switches, an output stage having r_2 switches and n_2 outlet links for each of r_2 switches. The network also has a middle stage of m switches, and each middle switch has at least one link connected to each input switch for a total of at least r_1 first internal links and at least one link connected to each output switch for a total of at least r_2 second internal links.

2) A multicast connection has a fanout of $\{1,2,\ldots,r_2n_2\}$. In the said three stage network, a multicast connection can be fanned out in **one or more of the three stages** (i.e., to set up the connection and to fanout up to a maximum of $\{r_2n_2\}$ times). Since every switch in the third stage has internal multicast capability, if

the multicast connections with fanout of $\{1,2,\ldots,r_2\}$ is designed and operated in noblocking manner, the multicast connection with fanout of $\{1,2,\ldots,r_2 n_2\}$ is automatically designed and operated in nonblocking manner. Accordingly all the prior art and the current invention fanout the multicast connection **in the third stage** as needed.

The specific problem definition (The solutions to which the prior art and the current invention differ):

So the nonblocking design and operation of the three stage network is dependant on **how the multicast connection is fanned out in the first and second stages.** It also directly effects **the number of middle stage switches m required for the nonblocking operation.** Applicant notes that this is a tough mathematical problem (and also the reason for many patents issued addressing this problem).

The solutions patented in the prior art:

All the prior art including U.S. Patent 5,801,641 by Yang et. al **do not address any specific general method** for the fanout of the multicast connect in the first and second stages (so that the multicast connection is fanned out in the complete three-stage network up to $\{1,2,\ldots,r_2 n_2\}$). The only novelty in all the prior art is **the number of middle stage switches m required for the nonblocking operation.** However the mathematical equations designed in the prior art for the minimum number of middle stage switches m **are complex, heuristic and higher values (hence expensive to design). They are also dependant on many parameters.** For example in U.S. Patent 5,801,641 by Yang et. al the number of middle stage switches m is given by:

$$m \geq \min\left((n_1 - 1)x + (n_2 - 1)r_2^{1/x}\right) \text{ where } 1 \leq x \leq \min(n_2 - 1, r_2)$$

This is a complex and expensive solution.

The solutions disclosed in the current invention:

The current invention presents an elegant and general method for the fanout of the multicast connection, specifically **in the first stage (at most two times) and second stage (any number of times)** (so that the multicast connection is fanned out in the complete three-stage network up to $\{1,2,\ldots,r_2 n_2\}$). The mathematical equation for the minimum number of middle stage switches m **is small (cheaper to design), simple (depends only on n_1 and n_2) and also mathematically the minimum. The equation is also independent of r_1 and r_2.** The three-stage network is also **strictly nonblocking** (no need to rearrange any of the existing connections) and m is given by:

$$m \geq 2 * n_1 + n_2 - 1$$

And applicant submits that the current invention solves a long existing problem of strictly nonblocking multicasting operation of the three-stage network with mathematically the best switching solution.

An example to show the superiority of the current invention over U.S. Patent 5,801,641 by Yang et. al:

To directly compare the number of middle stage switches m required for the nonblocking operation of the three stage network discussed in U.S. Patent 5,801,641 by Yang et. al on column 5 between lines 20-36, it requires m = 192 according to U.S. Patent 5,801,641 by Yang et. al.

where as it requires m = 95 (= 3*n-1 where n = 32) (also it operates the network in strictly nonblocking manner) according to the current invention. Accordingly applicant submits that this is a significant improvement over the prior art.

1) **The rejection of Claims 36-84, 93-109 under 35 USC 102(b)**

Accordingly applicant submit that the claims do comply with § 102(b) and therefore request withdrawal of this rejection.

2) **The rejection of Claims 1-35, 85-92 under 35 USC 103(a)**

Accordingly applicant submit that the claims do comply with § 103(a) and therefore request withdrawal of this rejection.

II. RESPONSE TO ADDRESS THE REJECTIONS 3 AND 4:

Claims: Cancel all the claims of record and substitute new claims as follows.